Lawrence Berkeley National Laboratory
Building 58 Electrical Safety Event
Of June 2, 2005

Report Date:	June 23, 2005
Incident Date:	June 2, 2005
Organizations Involved:	Accelerator & Fusion Research Division (AFRD) Engineering Division

Fact Finding Team

Team Leader:	Patricia Thomas, AFRD Environment, Safety and Health (ES&H) Administrator
Team Members:	Weyland Wong, Engineering Division ES&H Coordinator Richard DeBusk, LBNL Safety Manager Tom Caronna, LBNL Electrical Safety Officer
Observer:	Kim Abbott, Department of Energy, Berkeley Site Office, (DOE-BSO) Field Program Manager
Sponsors:	William Barletta, AFRD Director Kem Robinson, Engineering Division Director Phyllis Pei, Environmental Health and Safety (EH&S) Director

Report Contents

1. Executive Summary

This report describes an electrical safety incident that occurred on June 2, 2005 during a cleanup project near Bldg. 58 on the LBNL site. Personnel participating in this cleanup were briefed on the scope and hazards of this routine cleanup. During a discussion on the morning of June 2, the original cleanup scope was modified to add the cutting-back of electrical conduits and pipes. The Technical Associate assumed that there were no energized wires present in an outside area because the equipment had been removed approximately 10 years ago. The workers were not qualified to work on electrical utilities.

The Mechanical Technician proceeded with the work, cut into the conduit, and the PortaBand saw he was using contacted electrical wiring energized at 120 VAC. He did not receive a shock and no injuries resulted. The Mechanical Technician reported the situation to the Technical Associate and returned to the work area where the conduit was located. He removed the metal conduit by using a pipe wrench and hand turning. The wires were still energized when the conduit was removed. The worker did not receive a shock and no injuries resulted. The event was not reported to management until the next morning. An investigation was then initiated.

The investigation included a formal Fact Finding Team which produced this report. The interview comments and responses provided by those interviewed differed in event detail and sequence – although the differences were not substantial enough to affect the conclusions. The team concludes there were seven significant errors that occurred during or immediately after this work activity. Root and/or contributing causes have been determined for each error and judgments of need have also been developed to support the implementation of effective corrective actions by line organizations which will prevent a recurrence of this type of event. The primary judgments of need focus on communicating the essentials of safe work practices to workers across the Laboratory. Management and workers must understand the scope of work and associated hazards and controls before they begin work. The need to stop when unknown hazards are encountered is essential.

2. Facts

Personnel

List of key personnel involved:

AFRD Director
AFRD ES&H Administrator
Cleanup Project Review Team
Electrical Engineer
Electronics Technician
Engineering Division Director
Facilities Electrician
Facilities Electrical Supervisor
Fact Finding Team
LBNL Electrical Safety Officer
Mechanical Engineer
Mechanical Technician
Mechanical Technician Line Supervisor
Technical Associate
Witness (Physicist)

Note on organization and personnel involved:

Most of the cleanup work was to be performed by a Mechanical Technician. This technician reported to the Mechanical Technician Line Supervisor. The Mechanical Technician Line Supervisor was not in Building 58 on a continuing basis and assigned day-to-day oversight of the mechanical technicians to the Technical Associate. The Mechanical Technician who was performing cleanup work on the day of the incident had reporting relationships to the Mechanical Technician Line Supervisor, the Technical Associate, and the Mechanical Engineer. All of these personnel are employees of the Engineering Division and are matrixed to AFRD. The Mechanical Technician Line Supervisor became supervisor of Mechanical Technician and Technical Associate approximately 2 weeks prior to the incident.

Project Planning and Initiation Prior to the Incident

Mid-April 2005

In Mid-April 2005 the AFRD and Engineering Divisions began discussions on the cleanup of the Building 58 complex and the surrounding outdoor area as a safety improvement. A Cleanup Project Review Team was formed and consisted of three employees from the Engineering Division -- machine maintenance and tool repair group supervisor, an electronics technician superintendent, and a mechanical engineering department principal engineering technical associate. The Cleanup Project Review Team was tasked to review the conditions in the workplace and provide recommendations for improvement. These individuals completed their task on May 19, 2005 and submitted their report to the Engineering Division Director. The Engineering Division and AFRD agreed to share the cost of the cleanup. The report, entitled "Building 58 Safety and Cleanup Project" contains a scope of work and a list of general safety issues in the building that the work was aimed at correcting. The work scope included the statement, "The items generally mean everything that is not bolted down or hard wired in or plumbed in." The work document text clearly indicates that work on hard wired systems (such as electrical conduit) was not in the scope of the cleanup.

After May 19, 2005

At some point after May 19, the Engineering Division and AFRD Directors authorized this project and the Engineering Division Director assigned the Mechanical Engineer to take the lead in this effort. Both Division Directors committed the initial $30K to begin the project. Several meetings and walkthroughs occurred and the scope and hazards were generally discussed. The Mechanical Engineer and the Mechanical Technician Line Supervisor were involved in these walkthroughs. Work scope definition (clean up the immediate area) and hazard controls were discussed during the walkthroughs. The hazards identified for this job were lifting hazards and bumping hazards that required a hard hat. The clean-up project work began shortly after May 19, 2005.

Incident and Immediate Response

Thursday, June 2, 2005

- 0800-0900 The Mechanical Technician, Technical Associate and Mechanical Technician Line Supervisor met to discuss work to be performed that day on Building 58 outdoor area cleanup. They planned to remove materials from the area to make room to install shelves. During this meeting, they discussed cutting back several pieces of visible metal pipe and conduits protruding from the hillside and the T-condulet extending approximately 2 feet up from the concrete pad. Some of the metal pipes were visually inspected. During interviews with the Fact Finding Team one member of the work crew stated he felt a time pressure to complete this work quickly, but interviews with other members of the work crew contradict this perception. The

Mechanical Technician provided this information after he was given the opportunity to read/review the facts of the report. With regard to the observation about the electrical conduits, the Mechanical Technician stated that he asked the others present if there was a "need to call someone to check it out," or a similar statement. The Technical Associate stated to the work crew that he had been in the building 28 years and he believed the area "should be dead" since the transformer had been decommissioned and removed about 10 years ago. The Mechanical Technician Line Supervisor disputes the statement by the Mechanical Technician that he asked the others present if there was a "need to call someone to check it out", but did not dispute the agreement to proceed. They discussed what type of saw could be used to cut the pipes and conduits in the area. The Mechanical Technician Line Supervisor and Technical Associate left the immediate work area. The Technical Associate went to an adjacent high bay and did not have visual line-of-sight contact with the work site.

- ~9:00 The Mechanical Technician and Technical Associate each stated they looked into the T-condulet to visually confirm the status of the interior of the conduit. They did not see any wires.
- ~1000 After cleaning up a portion of the site, the Mechanical Technician successfully sawed off several pipes, using a PortaBand saw, without incident and there were no electrical wires present.
- ~1030 The Mechanical Technician stated he attempted to unscrew the conduit coupling; however, corrosion prevented him from disassembling the conduit arrangement. The Mechanical Technician stated that he began cutting the conduit coupling at an angle to weaken the corrosion and allow the conduit coupling to be removed by manually turning. The cutting was also performed with a PortaBand Saw with plastic handles that provided some electrical insulation. The employee was wearing safety glasses and leather gloves. No one else was in this immediate work area while the work was being performed. After cutting through the coupling threads, spraying lubricant and tapping the coupling, another unsuccessful attempt was made to remove the coupling. The Mechanical Technician cut further. Approximately half way through the electrical conduit coupling, the Mechanical Technician heard a loud popping sound and yanked the PortaBand Saw out of the cut to see a quarter-size section of the blade missing where 1/8" to 3/16" of the back edge of the blade remained intact to retain the full circumference of the blade. The Mechanical Technician understood that the saw blade had contacted live electrical wires. No electric shock occurred.
- ~1030 The Witness (Physicist) was coming down the stairs between building 53 and 58 and heard a sound from the area where the Mechanical Technician was working. The Witness walked directly to the Mechanical Technician who was walking away from the incident. The Witness stated that the Mechanical Technician appeared upset/shaken. The Mechanical Technician stated that he had cut into energized electrical wires, or a similar statement. The Witness walked approximately 75 feet into the adjacent Bldg. 58A high bay. The Electrical Engineer and Electronics Technician were working on an experiment in the Building 58A high bay. The Witness reported the incident to the Electrical Engineer. The Mechanical Technician walked into the Building 58 shop and reported the electrical event to the Technical

Associate. The Electrical Engineer asked the Electronics Technician to request the services of a Facilities Electrician to secure the energized wiring. The Electrical Engineer stressed this was important because live wires were present in the workplace. The Electronics Technician went to the electronics shop and called in the request into the Facilities Division Work Request Center. The Mechanical Technician returned to the work area where the conduit was located. The Mechanical Technician wanted to visually inspect the damage, so he removed the metal conduit by using a pipe wrench and hand turning. The wires were still energized when the conduit was removed. It did not occur to him that a continuing electrical hazard existed while he was removing the conduit. No electric shock occurred. The conduit arrangement was retrieved and inspected by the Fact Finding Team.

- ~1100 The Electrical Engineer and Technical Associate joined the Mechanical Technician at the incident scene. Together, the Electrical Engineer and Mechanical Technician put a 5-gallon plastic bucket over the wires and placed a "Danger High Voltage" sign next to the bucket.
- ~1230 The Technical Associate left Building 58. He attended a training class that afternoon. The Technical Associate stated that he was not aware of the requirement to immediately report the safety incident to management even though no injuries occurred.
- 1300-1400 The Facilities Electrician reported to Building 58 in response to the work request (WO6077) to secure live wires. The Facilities Electrician observed six wires on ground. The wires were of different length – some 2 feet long, others shorter. Some wires showed abrasion. Two wires were energized at 120 VAC. The breaker feeding this circuit did not trip. Facilities Electrician used instruments to determine the source of the power, secured power at the breakers and placed his personal lock and tag on each breaker. He then cut the wires, capped the wires and put them into the stub of the conduit. The conduit was then capped.

Friday, June 3, 2005

- 0700-0730 The Mechanical Technician reported to work and went to the Mechanical Technician Line Supervisor's office and reported the electrical event of the previous day. The Mechanical Technician Line Supervisor understood the Mechanical Technician to state that the Mechanical Technician removed the conduit and then started to cut the wires. The Mechanical Technician disputes that he stated he removed the conduit before cutting the wires. The evidence examined by the LBNL Electrical Safety Officer and the Mechanical Technician's direct testimony to the Fact Finding Team indicates that it is more likely that the wires were cut/contacted before the conduit was removed. Subsequent analysis in this report is based on the evidence and Mechanical Technician testimony to the Fact Finding Team. The Fact Finding Team believes that the outcome of the investigation is the same regardless of which understanding of the facts is used.
- ~0800 The Mechanical Technician Line Supervisor called the LBNL Electrical Safety Officer who did not answer, a message was left. The Mechanical Technician Line Supervisor also called the AFRD ES&H Administrator, did not reach her and left a message.

- ~1130 The Mechanical Technician Line Supervisor made contact with the AFRD ES&H Administrator, who initiated additional management notifications.
- ~1145 The AFRD ES&H Administrator contacted the LBNL Electrical Safety Officer. The LBNL Electrical Safety Officer reported to the incident scene at approximately 1200 with a Facilities Electrical Supervisor. With the Facilities Electrician, the Facilities Electrical Supervisor replaced the Facilities Electrician's personal locks and tags with an Administrative Lock and Tag on each breaker, as required by Chapter 18 of PUB 3000, "Lockout/Tagout".
- 1130-1300 Management in AFRD, Engineering Division, Office of Contract Assurance (LBNL Occurrence Reporting POC), and EH&S Division were notified. BSO Field Program Manager for AFRD and the BSO Occurrence Reporting Point of Contact (POC) were also notified in this time frame. BSO Occurrence Reporting POC notified the BSO EH&S POC. The BSO Site Office Manager was also notified.
- ~1400 The LBNL Electrical Safety Officer, AFRD ES&H Administrator, AFRD ES&H Coordinator, Engineering ES&H Coordinator, Facilities Division ES&H Coordinator and BSO Field Program Manager walked down the event scene outside Building 58 to begin reviewing information about the incident. The Mechanical Technician, Mechanical Technician Line Supervisor, Facilities Electrical Supervisor, and Electrical Engineer provided information. The LBNL Electrical Safety Officer and the Facilities Electrical Supervisor inspected the referenced wiring at this point.
- ~1630 The event was categorized under the Occurrence Reporting and Processing System (ORPS) as Group 2C Hazardous Energy Control, Category 3. AFRD and Engineering Division Directors agreed that AFRD would take responsibility for the occurrence reporting. Event notifications including verbal notification and a preliminary email of the facts as known at that time were submitted to LBNL management and BSO.
- ~1730 The BSO Site Office Manager sent an email to Dr. Orbach (SC-1) to advise him of the event.

Investigation Status

Monday, June 6, 2005 through Tuesday, June 21, 2005

- Preliminary fact-finding and reporting activities were conducted on Monday and Tuesday by the AFRD ES&H Administrator, Engineering Division ES&H Coordinator, and LBNL Electrical Safety Officer.
- Monday, June 6:
    1. The Electrical Engineer organized a safety stand down meeting for all Bldg. 58 employees. The LBNL Electrical Safety Officer described the event and the AFRD Director, Engineering Division Deputy Director, AFRD Program Head, Mechanical Engineer and Mechanical Technician Line Supervisor participated in discussion of the incident and safety awareness.
    2. The draft ORPS Notification Report was prepared for LBNL management review.
- Tuesday, June 7:

1. An on-scene discussion of the incident was conducted by the AFRD Director, BSO Site Manager, BSO Operations Team Lead, AFRD ES&H Administrator, AFRD ES&H Coordinator, Engineering ES&H Coordinator, and LBNL Institutional Assurance Officer.
2. The ORPS Notification Report was completed and submitted.

- Daily debriefs with senior management and BSO representatives were conducted each afternoon beginning Wednesday, June 8 through Friday, June 17.
- Wednesday, June 8, - In light of previous LBNL electrical safety events, a Fact Finding Team was formally appointed to add rigor to the event investigation. BSO assigned an observer (Field Program Manager) to the team.
- Thursday, June 9, the Fact Finding Team met and agreed on an approach to the investigation following Section 5.1 of PUB 3000, "Accident Investigation and Reporting." The Technical Associate, Facilities Division Electrician, Mechanical Technician Line Supervisor, Electronics Technician, Witness, and Mechanical Engineer were interviewed by the Fact Finding Team. The Mechanical Technician could not be interviewed because he was on sick leave June 7-9. The Electrical Engineer was at Los Alamos on LBNL business June 7-9.
- Friday, June 10, the Mechanical Technician and Electrical Engineer returned to LBNL and were interviewed. The Fact Finding Team provided a summary of the event information as known to the LBNL Director and key executives at 1030. The AFRD Division Director discussed the event and safety awareness at an AFRD all-hands meeting at 1330.
- Saturday, June 11 – Tuesday, June 21 Fact Finding Team worked on clarification of details and drafting of this report. On June 20-21, the Fact Finding Team reviewed the draft report for factual accuracy with the Mechanical Engineer, Mechanical Technician Line Supervisor, Technical Associate, and Mechanical Technician.

3. Analysis

The methods of analysis used for this investigation included interviews with key personnel, event scene observation, timeline reconstruction, a limited barrier analysis (discussing how Integrated Safety Management systems were challenged) during this event and expert opinion.

4. Errors Leading to Incident or Resulting from the Incident

Error 1 - Building 58 energized electrical conduit and associated wiring was not disabled and removed from the workspace when the building electrical transformer was decommissioned approximately 10 years ago as required by the National Electrical Code, 1999 Edition, Article 374.8 Sections A-D.

Error 2 - The potential discovery of hidden hazards and actions to be taken when unexpected conditions were encountered should have been communicated to workers. The original scope of work, hazards, and hazard controls for this project were verbally communicated during the pre-job meeting on the morning of June 2. The work authorization for this clean-up work (routine work) is consistent with the requirements of Section 6.2.2 of PUB 3000, "Work Authorization";

however, the history of the site should have been considered as a special circumstance in the work planning process.

Error 3 - The work crew altered the originally agreed upon scope of work and the hazard level increased at the June 2 briefing without an accompanying required hazard analysis. The workers discussed the additional scope and hazard of the electrical conduits removal during the pre-job briefing on June 2. The opinions and assumptions offered by the work crew do not meet the requirements for an analysis of new hazards, defined in Section 6.1 of PUB 3000 which states, "Once tasks have been defined, the hazards and risks associated with the activity must be determined."

Error 4 - The work crew should not have assumed the electrical conduits and associated wiring were de-energized. An opinion was offered by one member of the work crew and agreed upon by the others to remove the electrical conduits by cutting based on the assumption that the electrical conduits and associated wiring were de-energized. Section 8.4 of PUB 3000 states, "Always consider electrical equipment energized unless positively proven otherwise. When working on electrical equipment, treat the equipment as live until it is tested, locked, tagged shorted and/or grounded, as appropriate." All three members of the work crew had received training on electrical safety that included this required safe work practice (reference EH&S Training Course EHS 260).

Error 5 – The work crew exceeded their authority to modify the work scope and perform the work. A building cleanup project is not a frequent activity for Mechanical Technicians. While performing the cleanup tasks, the Mechanical Technician encountered a Facilities electrical system. Based on the morning briefing that the worksite was decommissioned, the Mechanical Technician proceeded. Section 8.5.1 of PUB 3000 states, "Only authorized Facilities Division personnel are considered by Laboratory management to be qualified to perform electrical wiring or other work directly connected to any facility electrical distribution system."

Error 6 - The Mechanical Technician returned to the event scene after reporting the incident and touched the electrical conduit that contained damaged, energized electrical wiring in violation of Section 8.4 of PUB 3000.

Error 7 - Personnel at the event scene on June 2 did not immediately report the incident to management as required by Section 15.3.1 of PUB 3000, "if they (employees) create or witness an adverse ES&H occurrence or condition in the course of performing work, they must immediately report the occurrence or condition to their division management".

5. Conclusions Including Root Causes and Contributing Factors

Each of the errors described above has been evaluated and assigned one or more root/contributing causes. To the degree possible, the causal codes in the Occurrence Reporting and Processing System manual LBID-2488, Causal Analysis Tree are used.

Error 1 - Building 58 energized electrical conduit and associated wiring was not disabled and removed from the workspace when the building electrical transformer was decommissioned approximately 10 years ago as required by the National Electrical Code, 1999 Edition, Article 374.8 Sections A-D.

Root Cause: A5B5C13 - *Accuracy/effectiveness of a change is not verified or not validated.* The facility was changed in the decommissioning. The removal of the wiring in the conduit as part of the decommissioning was not verified or validated resulting in a non-compliance and hazard.

Error 2 - The potential discovery of hidden hazards and actions to be taken when unexpected conditions were encountered should have been communicated to workers. The original scope of work, hazards, and hazard controls for this project was verbally communicated during the pre-job meeting on the morning of June 2. The work authorization for this clean-up work (routine work) is consistent with the requirements of Section 6.2.2 of PUB 3000, "Work Authorization"; however, the history of the site should have been considered as a special circumstance in the work planning process.

Root Cause: A4B3C08 – *Job scoping did not identify special circumstances and/or conditions.* The special circumstances are that LBNL is an old facility and there have been many changes over the years that could have left behind hidden hazards.

Error 3 - The work crew altered the originally agreed upon scope of work and the hazard level increased at the June 2 briefing without an accompanying required hazard analysis. The workers discussed the additional scope and hazard of removing the electrical conduits removal during the pre-job briefing on June 2. The opinions and assumptions offered by the work crew do not meet the requirements for an analysis of new hazards, defined in Section 6.1 of PUB 3000 which states, "Once tasks have been defined, the hazards and risks associated with the activity must be determined."

Root Cause: A4B5C04 - *Risks/consequences associated with a change are not adequately reviewed or assessed.* When the work scope was modified a hazard analysis was required. The initial hazard analysis did not include the hazard of cutting the electrical conduit.

Error 4 - The work crew should not have assumed the electrical conduits and associated wiring were de-energized. An opinion was offered by one member of the work crew and agreed upon by the others to remove the electrical conduits by cutting based on the assumption that the electrical conduits and associated wiring were de-energized. Section 8.4 of PUB 3000 states, "Always consider electrical equipment energized unless positively proven otherwise. When working on electrical equipment, treat the equipment as live until it is tested, locked, tagged shorted and/or grounded, as appropriate." All three members of the work crew had received training on electrical safety that included this required safe work practice (reference EH&S Training Course EHS 260).

Root Cause: A3B3C05 – *Incorrect assumption that a correlation existed between two or more facts.* The assumption made was that the electrical wiring was de-energized because the electrical transformer had been removed.

Error 5 - The work crew exceeded their authority to modify the work scope and perform the work. A building cleanup project is not a frequent activity for Mechanical Technicians. While performing the cleanup tasks, the Mechanical Technician encountered a Facilities electrical system. Based on the morning briefing that the worksite was decommissioned, the Mechanical Technician proceeded. Section 8.5.1 of PUB 3000 states, "Only authorized Facilities Division personnel are considered by Laboratory management to be qualified to perform electrical wiring or other work directly connected to any facility electrical distribution system."

Root Cause: A3B1C04 – *Infrequently performed steps were performed incorrectly.* Mechanical technicians perform building cleanup work infrequently and therefore were not familiar with the potential hazards or the appropriate actions to take when encountering unexpected conditions.

Contributing Cause: A4B1C01 – *Management policy guidance/expectations not well defined, understood, or enforced.* The management expectation that only facilities electricians would perform work on facility electrical distribution systems was defined in Chapter 8 of PUB 3000 but was not understood by the work crew on this task on this day and was not enforced by management.

Error 6 - The Mechanical Technician returned to the event scene after reporting the incident and touched the electrical conduit that contained damaged, energized electrical wiring in violation of Section 8.4 of PUB 3000.

Root Cause: A3B1C03 – *Incorrect performance due to mental lapse.* The mental lapse occurred when the Mechanical Technician returned to the event scene and touched the conduit containing energized electrical wiring without thinking about the hazard.

Error 7 - Personnel at the event scene on June 2 did not immediately report the incident to management as required by Section 15.3.1 of PUB 3000, "if they (employees) create or witness an adverse ES&H occurrence or condition in the course of performing work, they must immediately report the occurrence or condition to their division management".

Root Cause: A4B1C01 – *Management policy guidance/expectations not well defined, understood, or enforced.* The management expectation to report adverse ES&H occurrences or conditions was not well understood or communicated (i.e., not in EHS 10 training course).

Contributing Cause: A6B1C02 – *Training requirements not identified.* The management expectation to report adverse ES&H occurrences or conditions was not well communicated (i.e., not in EHS 10 training course).

6. Judgment of Needs

1. Addressing Error 1 and Root Cause A5B5C13

Error 1 - Building 58 energized electrical conduit and associated wiring was not disabled and removed from the workspace when the building electrical transformer was decommissioned approximately 10 years ago as required by the National Electrical Code, 1999 Edition, Article 374.8 Sections A-D.

Root Cause A5B5C13 Accuracy/effectiveness of a change is not verified or not validated.

> **Judgment of Need (JN01)** – The Facilities Division shall review the current process to ensure decommissioning of buildings/processes/equipment to de-energize and remove/disable excess electrical wiring is clear and effectively stated.
>
> **Judgment of Need (JN02)** – Management shall develop a plan to identify and address legacy issues.

2. Addressing Error 2 and Root Cause A4B3C08

Error 2 – The potential discovery of hidden hazards and actions to be taken when unexpected conditions were encountered should have been communicated to workers. The original scope of work, hazards, and hazard controls for this project was verbally communicated during the pre-job meeting on the morning of June 2. The work authorization for this clean-up work (routine work) is consistent with the requirements of Section 6.2.2 of PUB 3000, "Work Authorization"; however, the history of the site should have been considered as a special circumstance in the work planning process

Root Cause: A4B3C08 – Job scoping did not identify special circumstances and/or conditions.

> **Judgment of Need (JN03)** – EHS shall review Chapter 6 of PUB 3000, "Safe Work Authorizations," and determine the best method to incorporate a review of the history of hazards and special circumstances into the hazard analysis and work authorization process. The Engineering Division shall emphasize to employees the need for adequate job scope definition and hazard analysis for all work within the division.

3. Addressing Error 3 and Root Cause A4B5C04

Error 3 - The work crew altered the originally agreed upon scope of work and the hazard level increased at the June 2 briefing without an accompanying required hazard analysis. The workers discussed the additional scope and hazard of removing the electrical conduits removal during the pre-job briefing on June 2. The opinions and assumptions offered by the work crew do not meet the requirements for an analysis of new hazards, defined in Section 6.1 of PUB 3000 which

states, "Once tasks have been defined, the hazards and risks associated with the activity must be determined."

Root Cause A4B5C04 - Risks/consequences associated with a change are not adequately reviewed or assessed.

> **Judgment of Need (JN04)** – The EH&S Division shall prepare and disseminate a lessons learned from this event that shall include a discussion on the requirement for proper hazard analysis and use of safe work practices for all work.
>
> **Judgment of Need (JN05)** – The EH&S Division shall produce a presentation on the Lessons Learned from this event and shall provide this presentation to Division Directors, who shall communicate the information in a manner they determine appropriate.

4. <u>Addressing Error 4 and Root Cause A3B3C05</u>

Error 4 - The work crew should not have assumed the electrical conduits and associated wiring were de-energized. An opinion was offered by one member of the work crew and agreed upon by the others to remove the electrical conduits by cutting based on the assumption that the electrical conduits and associated wiring were de-energized. Section 8.4 of PUB 3000 states, "Always consider electrical equipment energized unless positively proven otherwise. When working on electrical equipment, treat the equipment as live until it is tested, locked, tagged shorted and/or grounded, as appropriate." All three members of the work crew had received training on electrical safety that included this required safe work practice (reference EH&S Training Course EHS 260).

Root Cause A3B3C05 - Incorrect assumptions that a correlation existed between two or more facts.

> **JN04** addresses this error and root cause.
>
> **Judgment of Need (JN06)** - Management shall reinforce with employees the requirement to consider all electrical equipment energized unless positively proven otherwise.

5. <u>Addressing Error 5 and Root Cause A3B1C04 – Individual justified actions by focusing on biased evidence.</u>

Error 5 - The work crew exceeded their authority to modify the work scope and perform the work. A building cleanup project is not a frequent activity for Mechanical Technicians. While performing the cleanup tasks, the Mechanical Technician encountered a Facilities electrical system. Based on the morning briefing that the worksite was decommissioned, the Mechanical Technician proceeded. Section 8.5.1 of PUB 3000 states, "Only authorized Facilities Division

personnel are considered by Laboratory management to be qualified to perform electrical wiring or other work directly connected to any facility electrical distribution system."

Root Cause: A3B1C04 – Infrequently performed steps were performed incorrectly.

JN05 addresses this error and root cause.

6. **Addressing Error 6 and Contributing Cause A4B1C01 – Management Policy guidance/expectations not well defined understood, or enforced.**

Error 6 - The Mechanical Technician returned to the event scene after reporting the incident and touched the electrical conduit that contained damaged, energized electrical wiring in violation of Section 8.4 of PUB 3000.

Contributing Cause: A4B1C01 – Management policy guidance/expectations not well defined, understood, or enforced.

JN05 addresses this error and root cause.

7. **Addressing Error 6 and Root Cause A3B1C03 – Incorrect performance due to mental lapse.**

Root Cause: A3B1C03 – Incorrect performance due to mental lapse.

JN06 addresses this error and root cause.

8. **Addressing Error 7 and Root Cause A4B1C01 – Management policy guidance/expectations not well defined.**

Error 7 - Personnel at the event scene on June 2 did not immediately report the incident to management as required by Section 15.3.1 of PUB 3000, "if they (employees) create or witness an adverse ES&H occurrence or condition in the course of performing work, they must immediately report the occurrence or condition to their division management".

Root Cause: A4B1C01 – Management policy guidance/expectations not well defined, understood, or enforced.

Judgment of Need (JN07) – EH&S shall review existing training courses and ensure the requirement for immediate reporting of abnormal events is included as appropriate. Additionally, EH&S shall communicate this requirement in the briefing discussed in JN05 and via the EH&S website.

9. **Addressing Error 7 and Contribution Cause A6B1C02 Training less than adequate.**

Contributing Cause: A6B1C02 – Training requirements not identified.

JN07 addresses this error and root cause.

7. Signature Page

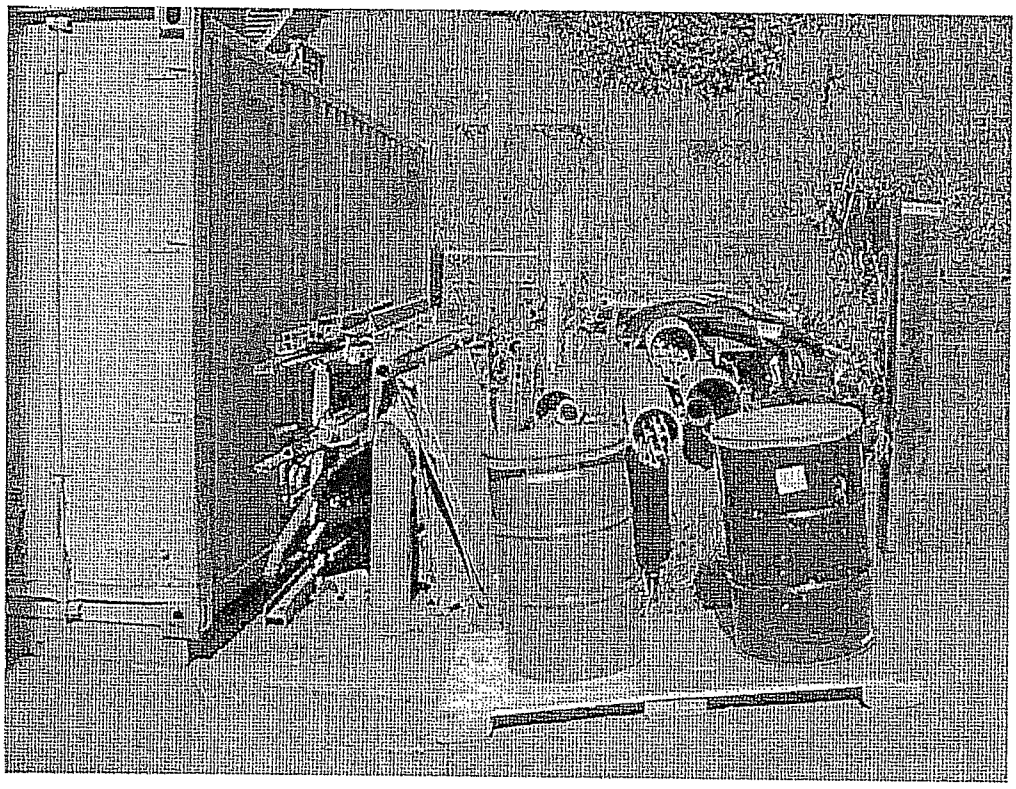
Provided at the end of the report.

Attachments

Attachment 1 – Incident Scene Photographs
Attachment 2 – Engineering Division Organization Chart for this Work Activity
Attachment 3 – Building 58 Safety and Cleanup Project Report
Attachment 4 – Electrical Hazard Analysis
Attachment 5 – Facilities Division Electrical Work Order
Attachment 6 – Charter for the Fact Finding Team

Attachment 1

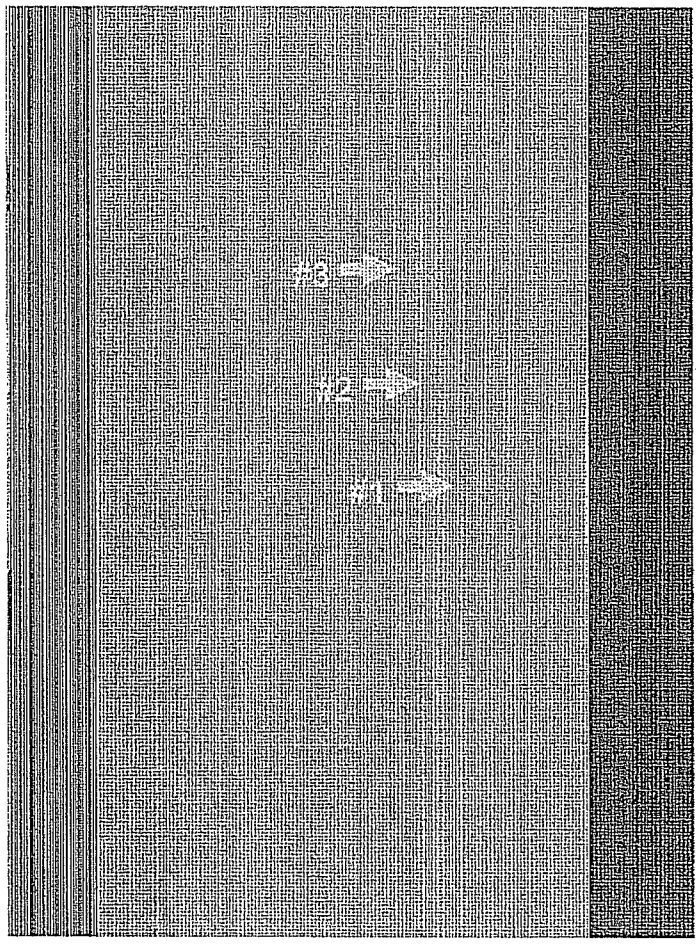
Incident Scene Photos

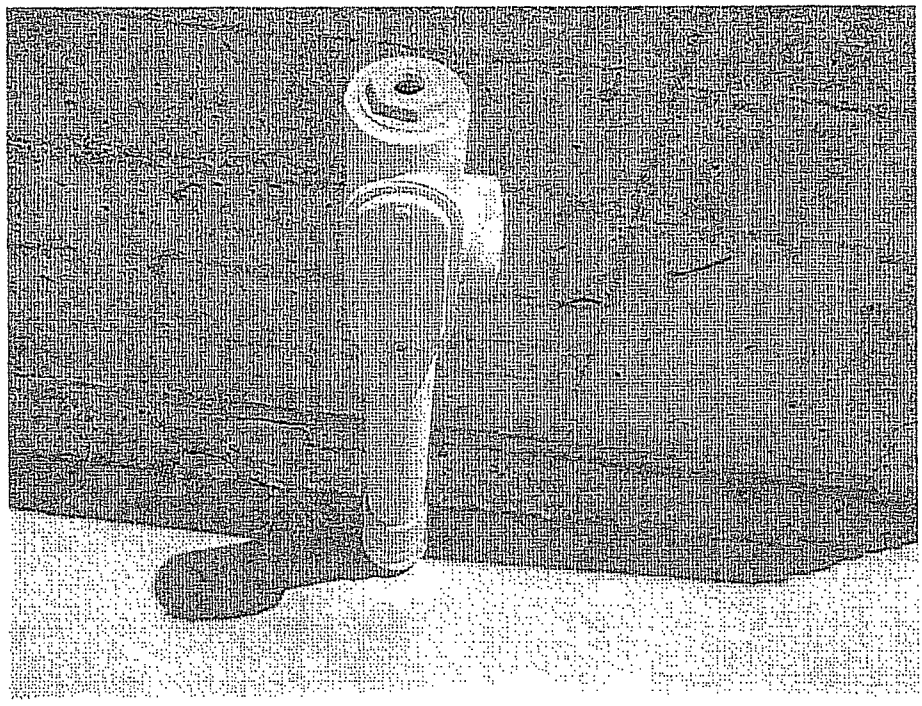


Building 58 Pad Area Before Cleanup Began
04/25/05

Building 58 Pad Area After Cleanup showing location of metal pipes

(Arrow 1 points to location of electrical conduit)



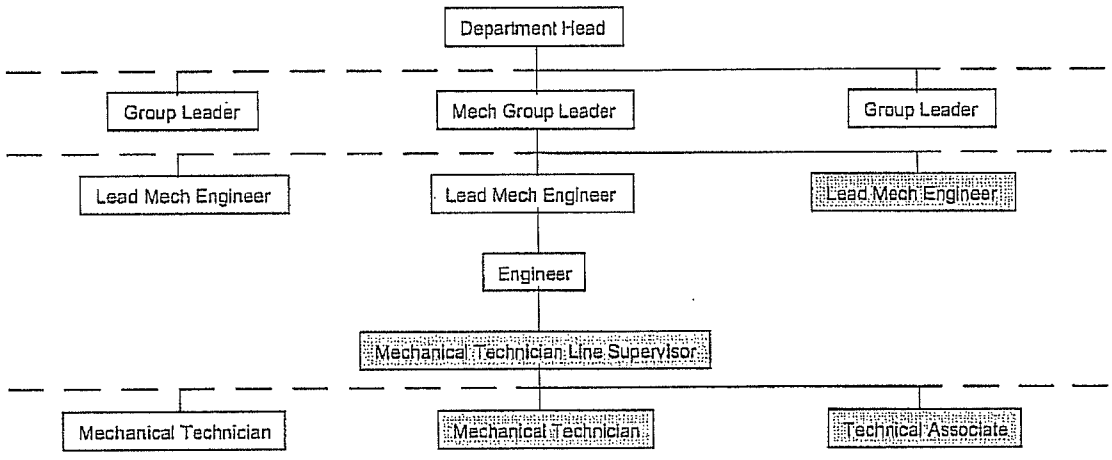


Building 58 Pad, Electrical Conduit (Coupling, pipe and T-condulet stack reconstructed atop pipe cap)

Attachment 2

Engineering Division Organization Chart

Engineering Division official line supervision and relationship of Mechanical Engineering Department staff involved



May 19, 2005

Building 58 Safety and Cleanup Project

The charge provided to the review team:

Serve as a consulting and advisory role in:
- Safety improvements and cleanup
- Both inside and outside of the B58 complex
- With overall emphasis on storage
- The focus is on safety
- That a professional appearance be achieved in the complex

The team is to provide:
- Written recommendations that include guidance and basis
- A set of short and long term goals with time lines and reporting intervals

The Team

- [machine maintenance and tool repair group supervisor]
- [electronics technician superintendent]
- [mechanical engineering department principal engineering technical associate]

The team has met on 5 different occasions, three of which involved walking through the B58 complex. Additional time was spent in discussions with several knowledgeable people concerning the status of equipment located in the B58 complex or seeking 'expert' advice on possible action that might be recommended. Project leads were also involved in the 'walk throughs' and discussions, primarily, [Mechanical Engineer} for HIF, as well as, [Mechanical Technician Line Supervisor] for SuperCon, and [ES&H Coordinator] for Engineering.

The Discovery

We found several items that would register on a safety inspection check list, many of which are attributable to poor housekeeping. The major problem as we see it is that there has been a practice of hoarding everything from pieces of metal to power supplies.

We understand the need and desire of a research group to keep a supply of things that will be required to expedite their research so that many things can be accomplished with a rapid turn around. However, any facility has a finite amount space for such accumulation, and as we see that the accumulation has far exceeded its limit.

Examples: materials stacked in corners and between cabinets and on top of cabinets and in carts and in boxes that are lying about on the floor or on top of other boxes of more material.

So as not to belabor the point I will stop here and go to the recommendations.

The Recommendations

1. A physical survey throughout the complex needs to be taken to identify which items are to be retained by the project and which items can be discarded. This survey should be inclusive of the entire complex; inside and outside of buildings, in cabinets, on top of cabinets, in corners, on carts, in offices, etc.
2. The 'items' generally mean everything that is not bolted down or hard wired in or plumbed in. We're thinking of things like, but not limited to:
   - Power supplies
   - Controllers
   - Rolls of cable and hose
   - Pipes and tubes
   - Plates and sheets of metal and plastic
   - Chemicals and solvents and paints
   - Components/chambers/beam line/etc.
3. Key people must be assigned to an area and/or a category of things to inventory. We also suggest that there be two basic types of inventorying taking place, one that would place a tag or marker on an item indicating whether it stays or goes, this would be for the larger more substantial things, then a second type that would deal with the smaller less expensive things where the item itself is either placed in a container for items to be kept or in a container for items that are to be discarded.
4. Permanent storage space must be designated and properly prepared to receive the items to be kept. There would be storage areas for chemicals, flammables, sheet/plate materials, pipes/tubes, smallish chunks of materials, hoses, cables. These areas then define the amount of material storage of the complex.
5. We recommend that laborers be employed, possibly by engineering, to assist with the relocating of the heavier/larger items.
6. We recommend that the shelving at the north end of B58 that is currently being used to store reels of electrical cable be replaced with a commercial Cable Reel Rack.
7. What logically follows is 'if there isn't room to store it then it, or something else of comparable volume, must be discarded'. Of course as cabinets are emptied of non-essential items they would become available for storage of 'essential' items.
8. The task is immense and complicated but as much as practicable the places where safety issues are a concern they should be addressed first.

The Specifics

Chemicals

1. A person (possessing Chemical Hygiene Safety Training, Chemical Management System (CMS) access, and Waste Generator training) needs to be appointed as Chemical Lead (CL) to be responsible for the oversight of chemicals in the 58 complex.
2. That temporary Satellite Accumulation Areas (SAA's) be setup to receive and stage chemical items that are to be discarded. This should be coordinated with [EH&S Waste Generator Assistant assigned to AFRD].
3. The CL and [EH&S Waste Generator Assistant assigned to AFRD] should receive the assistance of key people in the various areas which have chemicals, to separate those items from their inventory which can/need to be discarded and place them in the temp SAA's. This should be accomplished by the end of the first week, 5 working days, time line 5 (TL 5).
4. The CL and [EH&S Waste Generator Assistant assigned to AFRD] would then properly remove from the CMS inventory all items to be disposed of and prepare them for pickup by EH&S. Allow 10 working days. TL 15.
5. All retained items would then be inventoried in CMS and placed (with appropriate segregation) in approved storage. TL30.
6. A Flammable cabinet needs to be installed in the B58 basement shop to properly store the chemicals that are being used there. TL 5.
7. [EH&S Waste Generator Assistant assigned to AFRD] and [Engineering Division employee with chemical expertise] will be available for technical assistance.

We recommend that a special house cleaning effort be given to the sink area in SE corner of B58 shop very early on. Once that has been accomplished, to then call in an EH&S 'chemical expert' to review and evaluate the equipment, practices and controls with the bright-dip tanks/process and the electro-polisher and to determine what it would take for them to be brought into compliance with EH&S regulations. TL 30.

Materials

1. The physical survey, as described under Recommendations, is a many hands effort. TL 10.
2. Purchase a plate/sheet storage rack. TL 3.
3. Prepare the south end of the RTA to place plate rack and shelving for small piece storage. TL 4.
4. We suggest that the cargo-container at S end of the complex be outfitted with a second set shelves to increase storage capability. This currently used for HIF electronic storage. TL 10.
5. We suggest the long storage racks that are located outside the E wall be cleared of all items that are to be discarded so they can receive items that are to be kept. TL 5.
6. We suggest that the mezzanine in B58 used as storage for less dense items. Example: hoses. The load rating should be verified and abided by. Currently posted as 60 lbs,/sq.ft.. TL 10.
7. Areas of building 71 have been offered as medium term storage, 3 years maximum. We recommend that it be used sparingly, that most items being deemed 'need to keep' be sent to the warehouse. Possibly it's best use would be as a staging area where items could be sorted and palletized prior to being sent to B903. TL 30.

   As a side note: It is requested by the B71 manager that all items to be stored in B71 be placed in box pallets.

Safety Concerns

1. 55 gallon drums without secondary containment.
2. Items stored above the 36" height without restraint.
3. Food item stored in a posted non food item freezer.
4. Shop machines not seismically restrained.
5. Inadequate egress paths in many places.
6. Storage of equipment that are not adequately seismically restrained, in passageways or near exits
7. Chemical tanks that have no secondary containment.
8. Possible overloading of the mezzanine.
9. Possible overloading of the B58A control room.
10. Improper storage of materials in the restroom.

Maintenance Suggestions
We feel for this to be successful, it will require that everyone buys into it, that from the project heads down, each person becomes responsible for the equipment they have used and the mess they have generated.

Once the' tasks' has been completed they will require regular maintenance to sustain the results. We suggest that a policy of periodic cleanups, of going through cabinets and areas routinely to organize, put away items.

The storage areas need to be gone through on no less than a yearly basis and the unnecessary items discarded.

Personal work areas need to be brought to a professional appearing state and maintained on a daily basis.

That tools and equipment be properly stored at the end of each working day.

That the shop areas be addressed each evening, stowing of tooling, machine wipe downs, floors swept.

That a policy of spending a few hours each week in the shop areas washing down and caring for the equipment (particularly machine tools).

Schedules
Obviously the completion of this task will take a considerable amount of time. We suggest that the time lines be observed as stated in the specifics as much as possible. This should provide for a strong start and very noticeable improvements will be quickly achievable.

The longer term things, such as items being sent to the warehouse, conceivably drag out for several months as things are organized and packaged for storage. Also in the realm of long term items we recommend that the old cabinets in the shop be replaced with more efficient and capable new ones.

For the shop, we also recommend that more suitable wall coverings be installed along with a fresh coat of paint to brighten things up.

In the long term, there must be a change in culture. That the requirement of good house cleaning, properly wrapping up a project, either at the end of the day or at the conclusion of the project are expected. Of course we are busy, and that's good, but rarely do we become so short of time that we can not cleanup behind ourselves.

Reporting
We suggest that the contact people; [Mechanical Engineer] for HIF and [Mechanical Technician Line Supervisor] for SuperCon issue a weekly report noting the current progress of the task.

The team members will be available for questions and clarification as required.

Attachment 4

Electrical Hazard Analysis
(Prepared by Tom Caronna, LBNL Electrical Safety Officer)

1. Energy levels and shock hazard analysis for the activity of cutting the conduit with live wires

   - The conduit contained NO Arc Blast hazards
   - The conduit did contain Shock hazard:
     - The panel feeding the conduit is at the 120/208 volt level.
     - Fault currents are limited by fault protection and distance.
     - There was a potential for an electrical shock
   - The conduit is a very low impedance ground (<1 ohm):
     - The tool used for penetration was a metal band saw blade.
     - The blade was tightly contained in the conduit as it cut (making the tool very near ground potential).
   - The employee was a very high impedance path to ground (quantitative values unknown):
     - The employee had both hands on the plastic handles of the tool.
     - The employee was wearing proper work apparel and leather work gloves (not electrical personal protection equipment (PPE).
     - The employee did not experience any electrical shock

2. Energy levels and shock hazard analysis for the follow on activity of removing the conduit

   - Same as above, there was a potential for a 120/208 electric shock.
   - The worker did not receive an electric shock.

Attachment 5

Facilities Division Electrical Work Order

Run Date: 06/17/05
Run Time: 14:01

LBNL Facilities Large Work

HAZARDS? N

WO Number: WO6077
Title: Conduit with "hot" wires exposed 06025
Location: 058 - Building: 058
Equipment:

Project ID: Z41701
WO Priority: -
Work Type: NBC - Non-Building Costs
Status: WCLOS - Waiting to be Closed

Description:

Bldg. 58 back patio area - there is a conduit with "hot" wires - please fix as soon as possible.

Date/Time: 6/2/2005 - 10:49
Requester: 800751 - Rogers,Craig F
Org Code: EGEE - Electronic Engineering
Location: 058-0001

Phone: 510/486-5531
Fax:
EPO: C_Rogers@lbl.gov

Supervisor: Murphy,James W
Phone: 510/486-4175
Fax:
Location: 076-0212E

EPO: JWMurphy@lbl.gov
Lead Craft: FATSE
Description: Supervisor/Staff
Crew: CREW09

Target Start:
Actual Completion: 6/7/2005

Parent WO:
Sub WO's: 0

Labor Estimates

Craft	Est. Hrs.	Operation Comments
Construction Electrical	0	

Estimated Totals

Total Est. Hours:	
Total Est. Materials:	$0.00
Total Est. Tools:	$0.00
Total Est. Labor + Burden:	$0.00
Total Est. Service:	$0.00
Total Estimated Cost:	$0.00

Attachment 6

Charter for the Fact Finding Team

Rick Gough, Acting Division Director, AFRD has authorized a Fact Finding Team to determine the facts concerning the June 2, 2005 electrical event in Building 58 (Occurrence Report OAK-LBL-ARFD-2005-TEMP) and to recommend corrective actions to prevent recurrence. Alan Paterson, Acting Division Director for Engineering and Eugene Lau, Acting Division Director for EH&S have concurred with this course of action. The team will be led by Pat Thomas, AFRD EH&S Administrator and will include Weyland Wong (Engineering Division Safety Coordinator), Tom Caronna (AFRD EH&S Liaison and LBNL Electrical Safety Officer) and Richard DeBusk (LBNL Safety Manager). The team will conduct the fact finding utilizing processes defined in Chapter 5 of PUB 3000, "Accident Investigation and Reporting." John Chernowski is serving as an advisor to the team on accident investigation processes. Kim Abbot and Hattie Carwell of DOE-BSO have been advised of this activity to allow them the opportunity to provide oversight as they deem appropriate.

The Fact Finding team will convene on Thursday, June 9 and will target completion of their draft report by Friday, June 10 (unless circumstances require more time). The parties involved will provide comment to the draft report and the team will target completion of the report during the week of June 13.

The report was prepared by:

Patricia Thomas 6/23/05
Patricia Thomas, AFRD EH&S Administrator, Fact Finding Team Leader

Richard E DeBusk 6/23/05
Richard DeBusk, LBNL Safety Manager, Team Member

Weyland Wong 06/23/05
Weyland Wong, Engineering Division EH&S Coordinator, Team Member

Thomas Caronna 6-23-05
Thomas Caronna, LBNL Electrical Safety Officer, Team Member

This report was accepted by:

24 June 2005
William A. Barletta, AFRD Division Director

24 June 2005
Ken Robinson, Engineering Division Director

27 June 2005
Phyllis Pei, EH&S Division Director